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DOI:

[10.3329/dujps.v7i1.1217](https://doi.org/10.3329/dujps.v7i1.1217)

Document Version

Early version, also known as pre-print

[Link to publication record in King's Research Portal](#)

Citation for published version (APA):

Rahman, M. S., Begum, B., Chowdhury, R., Rahman, K., & Rashid, M. A. (2008). Preliminary cytotoxicity screening of some medicinal plants of Bangladesh. *Dhaka University Journal of Pharmaceutical Sciences*, 7(1), 47-52. <https://doi.org/10.3329/dujps.v7i1.1217>

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Preliminary Cytotoxicity Screening of Some Medicinal Plants of Bangladesh

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ABSTRACT: The cytotoxic activity of the methanolic extracts of 35 plant species, including 28 traditionally used plants of Bangladesh was evaluated by the brine shrimp lethality bioassay technique. Among these, 19 plant extracts exhibited significant toxicity to brine shrimps with LC₅₀ less than 10 µg/ml.

Key words: Cytotoxic activity, Brine shrimp lethality bioassay.

INTRODUCTION

Plants are the natural reservoir of many antimicrobial and anticancer agents. Bangladeshi people have traditional medical practice as an integral part of their culture. A lot of medicinal plants are available for the treatment of various diseases. However, scientific studies have been conducted only to a limited extent with few medicinal plants.¹⁻⁴ In this investigation, 35 locally used plants were selected and tested to justify their existing bioactivities by the brine shrimp lethality bioassay.⁵ The method utilizes *in vivo* lethality in a simple zoological organism brine shrimp nauplii as a convenient monitor for screening cytotoxicity of the plant extracts which can be further correlated with its anticancer potentiality and other bioactivities.

MATERIALS AND METHODS

Plant collection. The plants selected for the study (Table 1) were collected from Dhaka, Chittagong and Khulna districts of Bangladesh during January - April 2004 and identified at the Department of Botany, University of Dhaka where voucher specimens for these collections are maintained.

Extraction. The air-dried and powdered plant materials were separately extracted with methanol for 5 days at room temperature with occasional shaking and stirring. The extracts were then filtered off through a cotton plug and finally with Whatman no.1 filter papers. The volume of the filtrate was reduced using a Buchii rotary evaporator at low temperature and pressure.

Bioassay. Brine shrimp lethality bioassay⁵ technique was applied for the determination of cytotoxic property of the plant extractives. Vincristine sulphate and DMSO were used as positive and negative control, respectively.

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Table 1. LC₅₀ of methanol extracts of some medicinal plants of Bangladesh

Plant (Family)	Uses in traditional medicine	RMC	RPPS	LC ₅₀ (µg/ml)
<i>Aglaia roxburghiana</i> (Meliaceae)	Dysentery, leucoderma, leprosy, fever, thirst, tumors, vomiting. ⁶	24, 25-epoxy-29-norcycloartan-3-ol, 29-norcycloart-23-ene-3, 25-diol, 24,25-epoxy-29-nor-24-cycloarten-3β-ol, roxburghiline, hydroxyroxburghiline, aglaroxin-A, roxburghiadiol A. ¹⁰	Terpenoids, alkaloids	11.66 ± 1.10
<i>Amoora cucullata</i> (Meliaceae)	Inflammation. ⁶	No information found.	Steroids	5.16 ± 1.13
<i>Amoora rohituka</i> (Meliaceae)	Cancer, tumours, spleen and liver disease, rheumatism. ⁷	6b,7b-epoxyguaia-4-en-3-one, 6b,7b-epoxy-4b,5-dihydroxyguaiane, ¹¹ stigmasta-5,24(28)-dien-3β-O-β-D-glucopyranosyl-O-α-L-rhamnopyranoside, ¹² 7-keto-octadec-cis-11-enoic acid. ¹³	Terpenoids	5.95 ± 0.94
<i>Brunfelsia americana</i> (Solanaceae)	No information found.	No information found.	Steroids	7.43 ± 1.17
<i>Brunfelsia latifolia</i> (Solanaceae)	No information found.	No information found.	Steroids	6.82 ± 0.47
<i>Buchanania lanzan</i> (Anacardiaceae)	fever, thirst, diarrhea, itch. ⁸	Myricetin 3'-rhamnoside-3-galactoside. ¹⁴	flavonoid	63.42 ± 1.34
<i>Chukrasia tabularis</i> (Meliaceae)	As an astringent and antidiarrhoeic. ⁶	tabulalides A-E, ¹⁵ tabularin, ¹⁶ scopoletin, melianone, ¹⁷ chukrasin A-E. ¹⁰	Terpenoids, coumarins	15.16 ± 1.27
<i>Combretum coccineum</i> (Combretaceae)	No information found.	A hydroxylated mansumbinen-28-oic acid. ¹⁸	Terpenoids	5.95 ± 0.37
<i>Erioglossum edule</i> (Sapindaceae)	Fever, whooping cough. ⁶	No information found.	Steroids	158.74 ± 1.24
<i>Ficus indica</i> (Moraceae)	Relieve toothache, rheumatism, lumbago, inflammations, diarrhoea, dysentery, vomiting, biliousness. ⁷	Bengalenoside, leucoanthocyanidins, leucoanthocyanin glycoside, betasitosterol glycoside, mesoinositol, friedelin, beta-sitosterol, quercetin-3-galactoside and rutin, tiglic acid ester of gamma-tarxerol, cyanidin rhamnoglycoside, ficusin and bergaptin. ⁷	Steroids, terpenoids, phenolics	17.67 ± 1.17
<i>Garuga pinnata</i> (Burseraceae)	Asthma, opacity of conjunctiva. ⁷	Garuganins I-VI, eupha-7, 24-diene-1, 3- diol, eupha-7, 24-diene-3, 11, 16-triol. ¹⁰	Terpenoids	37.72 ± 3.10
<i>Indigofera tinctoria</i> (Papilionaceae)	Epilepsy, nervous disorder, bronchitis, sores, old ulcers. ⁷	Galactomannan [19], indirubin. ²⁰	Steroids, terpenoids	1.86 ± 1.14
<i>Lannea coromandelica</i> (Anacardiaceae)	Leprous and obstinate ulcers, toothache, mouth sores, impotency. ⁹	(2R,3S)-(+)-3',5'-dihydroxy-4',7'-dimethoxydihydroflavonol, (2R,3R)-(+)-4',5,7-trimethoxydihydroflavonol, (2R,3R)-(+)-4',7-di-O-methyldihydroquercetin, (2R,3R)-(+)-4',7-di-O-methyldihydrokaempferol and (2R,3R)-(+)-4'-O-methyldihydroquercetin [21], Quercetin-3-arabinoside, ellagic acid, β-sitosterol, physcion, physcion anthranol B, leucocyanidin. ²²	Phenolics	53.59 ± 1.33
<i>Nephelium litchi</i> (Sapindaceae) Syn: <i>Litchi chinensis</i>	Neurological disorders, smallpox, throat infection. ⁷	Folic acid, L - ascorbic acid, cyanidin-3-glucoside, cyanidin-3-rutinoside, malvidin-3-acetylglucoside, α-[methylene cyclopropyl] glycine. ⁷	Steroids, terpenoids	143.98 ± 1.64
<i>Nephelium longana</i> (Sapindaceae) Syn: <i>Euphoria longan</i>	Anthelmintic, fever. ⁶	Saponin, ⁶ 2-amino-4-methylhex-5-ynoic acid, 2-amino-4-hydroxymethylhex-5-ynoic acid, 2-amino-4-hydroxyhept-6-ynoic acid. ²³	Steroids, terpenoids, amino acids.	2.21 ± 0.66
<i>Passiflora coccinea</i> (Passifloraceae)	No information found.	Passicoccin. ²⁴	Cyanogenic glycoside	131.95 ± 1.33

(Contd.)

Table 1 (Contd.)

Plant (Family)	Uses in traditional medicine	RMC	RPPS	LC ₅₀ (µg/ml)
<i>Petunia meleagris</i> (Solanaceae)	No information found.	No information found.	Steroids	53.59 ± 2.31
<i>Petunia phoenica</i> (Solanaceae)	No information found.	No information found.	Steroids	30.31 ± 1.28
<i>Petunia punctata</i> (Solanaceae)	No information found.	No information found.	Steroids	4.90 ± 1.64
<i>Petunia violaceae</i>	No information found.	No information found.	Steroids	41.14 ± 1.67
<i>Phyllanthus reticulatus</i> (Euphorbiaceae)	Spongy and bleeding gums, as astringent, diuretic. ⁶	Friedelin, sitosterol, friedelan-38-02 glochidonol, 21a-hydroxyfriedelan-3-one, 21a-hydroxyfriedel-4(23)-en-3-one, betulinic acid. ²⁵	Terpenoids, steroids	3.72 ± 1.98
<i>Pongamia glabra</i> (Leguminosae)	Bleeding piles, fistulous sores, bronchitis, gonorrhoea, whooping cough, as tonic. ⁹	Karanjin, ovalitenone, pongachromene, lanceolatin, betulinic acid, caffeic esters, pongapin, glabrachromene, desmethoxykanugin, (-)-isoglabrachromene, kanugin, glabra-ii, fisetin tetramethyl ether, 5-methoxy-3',4'-methylenedioxy-2'',2''-do(7,8-6'',5'') flavone, ²⁶ glabrone, ²⁷ pongagallone-a, pongagallone-b, ²⁸ isopongachromene, pongamol, kanjone, pongaglabrone, ²⁹ glabrachalcone, ³⁰ isopongaglabol and 6-methoxyisopongaglabol, 5-methoxyfurano(8,74'',5'')flavone, 5-methoxy-3',4'-methylenedioxyfurano(8,7-4'',5'')flavone, ovalichromene B, cycloart-23-ene-3p,25-diol, friedelin, and β-sitosterol-β-D-glucoside, ³¹ pongaglabol, aurantiamide acetate ³² pongaglabrone. ³³	Flavonoids	8.54 ± 1.31
<i>Pterospermum suberifolium</i> (Sterculiaceae)	Smallpox, hemicrania. ⁶	3,4-Di-O-methylrhamnose 2,3,4,6-Tetra-O-methylglucose 2,3,6-Tri-O-methylglucose 2,3,4,6-Tetra-O-methylgalactose 2,3,6-Tri-O-methylgalactose, 4,6-Di-O-methylgalactose 3,6-Di-O-methylgalactose. ³⁴	Phenolics	2.48 ± 0.88
<i>Quisqualis indica</i> (Combretaceae)	Diarrhea, fever, rickets in children, boils, ulcers, helminthiasis. ⁷	Quisqualic acid, ³⁵ quisqualin A. ¹⁰	Amino acids, tannins	4.42 ± 1.57
<i>Semecarpus anacardium</i> (Anacardiaceae)	Scrofulous, venereal and leprosy infections, nervous debility. ⁶	Anacardic acid, semicarpol, bhillawanol, monolefin I, diolefin II, bhillawanol-A, bhillawanol-B, amentoflavone tetrahydroamentoflavone, tetrahydrobustaflavone, jeediflavanone, semecarpufllavanone, gallufllavanone anacardufllavanone, anacardoside, ³⁶ semecarpetin, nallaflavanone, ³⁷ jeediflavanone, ³⁸ semecarpufllavanone, ³⁹ gallufllavanone, ⁴⁰ O-trimethyl biflavanone A ₁ , O-trimethyl biflavanone A ₂ , O-Tetramethyl biflavanone A ₁ , O-hexamethyl bichalcone A, O-dimethyl biflavanone B, O-heptamethyl bichalcone B ₁ , O-hexamethyl bichalcone B ₂ , O-tetramethyl biflavanone C. ⁴¹	Phenolics	35.36 ± 0.94
<i>Shorea robusta</i> (Dipterocarpaceae)	Ulcers, wounds, gonorrhea, leprosy, helminthiasis. ⁸	9,10-dihydroxystearic acid, 3,25-epoxy-1,2,3,11-tetrahydroxy-12-ursen-28-oic acid, ⁷ 28-nor-12-ursen-3-ol, shorea phenol, 2,3,23-trihydroxy-11-methoxy-12-ursen-28-oic acid. ¹⁰	Terpenoids	3.50 ± 1.38

(Contd.)

Table 1 (Contd.)

Plant (Family)	Uses in traditional medicine	RMC	RPPS	LC ₅₀ (µg/ml)
<i>Solanum indicum</i> (Solanaceae)	Astringent, carminative, cardiac tonic, aphrodisiac. ⁶	Isoanguivine, protodioscin, solasonine and solamargine, indioside A-E. ⁴²	Steroids	4.42 ± 0.67
<i>Solanum ferox</i> (Solanaceae)	Coughs, asthma, fever, vomiting, sore throat, gonorrhea. ⁶	Carpesterol, solanocarpine. ⁶	Steroids, alkaloids	12.92 ± 1.49
<i>Spondias mangifera</i> (Anacardiaceae)	Antiscorbutic, astringent, dysentery, diarrhoea, vomiting, gonorrhoea and leucorrhoea. ⁷	3, 16-dihydroxy-12-oleanen-28-oic acid -3-O-[β-D-galactopyranosyl-(1→5) xylopyranoside]. ¹⁰	Terpenoids	4.42 ± 0.99
<i>Swintonia floribunda</i> (Anacardiaceae)	No information found.	No information found.	Steroids	32.66 ± 1.68
<i>Terminalia bellirica</i> (Combretaceae)	Hepatitis, breathing problem, coughs, eye disease, constipation purgative. ⁷	Cardenolide, ⁴³ 2-dotriacontanol, bellericagenin B, bellericaside B, termilignan, bellericagenin A, bellericaside A, thannilignan, 9-tritriacontanone, ¹⁰ sitosterol, gallic acid, ellagic acid, ethyl gallate, galloyl glucose, mannitol, glucose, galactose, fructose and rhamnose, belleric acid, bellericoside, arjungenin, arjunglycoside. ⁴⁴	Terpenoids, phenolics, steroids,	3.62 ± 1.35
<i>Terminalia chebula</i> (Combretaceae)	Indigestion, constipation jaundice, piles, painful menstruation, asthma, colic, as diuretic and cardiogenic. ⁶	Terflavin A, chebulagic acid, chebulinic acid, corilagin, 2α-hydroxymicromeric acid, luteolic acid, 12-oleanene-2,3,19,23,28-pentol, terchebin, terchebulin, terflavin D, terfalvin B, 1,3,6-trigalloyl glucose. ¹⁰	Phenolics	8.85 ± 0.38
<i>Trachyspermum ammi</i> (Umbelliferae)	Diarrhea, colic, flatulence, indigestion, cholera, dyspepsia. ⁶	An essential oil containing thymol. ⁶	Terpenoids	4.95 ± 1.61
<i>Xylocarpus granatum</i> (Meliaceae)	Dysentery, diarrhea, and other abdominal problems. ⁷	xylocensins O-P, xylocensins Q-V, ⁴⁵ Xylocensin L, ⁴⁶ xylocensin K, ⁴⁷ xylocensin I-J. ⁴⁸	Terpenoids	6.81 ± 0.22
<i>Zizyphus mauritiana</i> (Rhamnaceae)	Diarrhea, fever, delirium, gout, wounds and ulcers. ⁷	Mauritine A-H, frangulofoline, amphibine B, amphibine D-F, ⁴⁹ zizogenin, ⁵⁰ laccic acid D. ¹⁰	Alkaloids	22.75 ± 0.34

RMC, reported major constituents; RPPS, results of preliminary phytochemical screenings; LC₅₀, 50% of lethal concentration; LC₅₀ were calculated as mean ± SD (n=3).

4 mg of each of the extractives was dissolved in DMSO and solutions of varying concentrations such as 400, 200, 100, 50, 25, 12.50, 6.25, 3.125, 1.563 and 0.781 µg/ml were obtained by serial dilution technique. Then the solutions were added to the premarked vials containing ten live brine shrimp nauplii in 5 ml simulated sea water. After 24 hours, the vials were inspected using a magnifying glass and the number of survived nauplii in each vial was counted. From this data, the percent (%) of lethality of the brine shrimp nauplii was calculated for each concentration. The median lethal concentration

(LC₅₀) of the test samples was obtained by a plot of percentage of the shrimps killed against the logarithm of the sample concentration.

Statistical analysis. The experiment was conducted in triplicate and the LC₅₀ were calculated as mean ± SD (n=3).

RESULTS AND DISCUSSION

In the present study, extracts of 35 local plants used in Bangladesh were evaluated by the brine shrimp lethality bioassay using the procedure

designed by Meyer *et al.*⁵ The LC₅₀ values of the brine shrimp assay obtained for extracts of these medicinal plants are listed in Table 1.

The methanolic extract of *Indigofera tinctoria* showed the highest activity with LC₅₀ 1.86 µg/ml. The extracts of *Nephelium longan*, *Pterospermum suberifolium*, *Shorea robusta*, *Terminalia bellerica* and *Phyllanthus reticulatus* exhibited strong brine shrimp lethality with LC₅₀ values of 2.21, 2.48, 3.50, 3.62 and 3.72 µg/ml, respectively. In addition, *Solanum indicum*, *Quisqualis indica*, *Spondias mangifera*, *Petunia punctata*, *Trachyspermum ammi*, *Amoora cucullata*, *Amoora rohituka* and *Combretum coccineum* have also shown significant brine shrimp lethality and the LC₅₀ values were found to be lower than 6.00 (Table 1). On the otherhand, *Xylocarpus grantum*, *Brunfelsia latifolia*, *Brunfelsia americana*, *Pongamia glabra* and *Terminalia chebula* showed moderate cytotoxicity with LC₅₀ less than 10.00 µg/ml.

It is observed that 19 plants extracts were highly lethal to brine shrimp nauplii out of the 35 plants used in the study. This indicates that these plants contain potential bioactive compounds, which if properly and extensively studied, could provide many chemically interesting and biologically active drug candidates, including some with potential antitumor and antiproliferative properties. A thorough chemical study is required to isolate the molecules that are responsible for the activities.

ACKNOWLEDGEMENT

We wish to thank the Ministry of Science and information & Communication Technology, Government of the Peoples' Republic of Bangladesh for partial financial support to carry out the research.

REFERENCES

1. Rashid, M.A., Hasan, C.M., Choudhury, S.A.R., Begum, B. and Rahman, S. 1997. Ethnopharmacological investigation of medicinal plants of Bangladesh. *Bangladesh Journal of Physiology and Pharmacology* **12**, 25-29.
2. Nutan, M.T.H., Hasnat, A., Rashid, M.A. and Rahman, S. 1997. Cytotoxic and antiproliferative medicinal plants of Bangladesh a review Bangladesh. *Journal of Life Sciences* **9**, 61-67.
3. Haque, N., Choudhury, S.A.R., Nutan, M.T.H., Rahman, G.D.S. and Rashid, M.A. 2000. Antibacterial screening of some medicinal plants of Bangladesh. *Bangladesh Journal of Physiology and Pharmacology* **15**, 52-54.
4. Haque, N., Choudhury, S.A.R., Nutan, M.T.H., Rahman, G.D.S. and Rashid, M.A. 2000. Evaluation of antitumor activity of some medicinal plants of Bangladesh by potato disk bioassay. *Fitoterapia* **71**, 544-549.
5. Meyer, B.N., Ferringni, N.R., Puam, J.E., Lacobsen, L.B., Nichols, D.E. and McLaughlin J.L. 1982. Brine shrimp: a convenient general bioassay for active constituents. *Planta Medica* **45**, 31-32.
6. Chopra, R.N., Nayar, S.L. and Chopra, I.C. 1956. *Glossary of Indian Medicinal Plants*, New Delhi, CSIR.
7. Ghani, A. 1998. *Medicinal plants of Bangladesh*. 2nd ed. Dhaka; Asiatic Society of Bangladesh.
8. Kirtikar, K.R., Basu, B.D., Blatter, E., Caius, J.F. and Mahaskar, K.S. 1980. *Indian medicinal plants*. 2nd ed. Singh B & Singh MP publishers.
9. Yusuf, M., Chowdhury, J.U., Wahab, M.A. and Begum, J. 1994. *Medicinal Plants of Bangladesh*. 1st ed. Dhaka; Bangladesh Council of Scientific and Industrial Research (BCSIR).
10. *Dictionary of Natural Products*, Chapman and Hall, 2002.
11. Chowdhury, R., Hasan, C.M. and Rashid, M.A. 2003. Guaiane sesquiterpenes from *Amoora rohituka*. *Phytochemistry* **62**, 1213-1216.
12. Bhatt, S.K., Saxena, V.K. and Nigam, S.S. 1981. A new saponin from seeds of *Amoora rohituka*. *Phytochemistry* **20**, 1749-1750.
13. Daulatabad, C.D. and Jamkhandi, S.A.M. 1997. A keto fatty acid from *Amoora rohituka* seed oil. *Phytochemistry* **46**, 155-156.
14. Arya, R., Babu, V., Ilyas, M. and Nasim, K.T. 1992. Myricetin 3'-rhamnoside-3-galactoside from *Buchanania lanzan* (anacardiaceae). *Phytochemistry* **31**, 2569-2570.
15. Nakatani, M., Abdelgaleil, S.A.M., Mona, M.G., Saad, M.M.G., Huang, R.C., Doe, M. and Iwagawa, T. 2004. Phragmalin limonoids from *Chukrasia tabularis*. *Phytochemistry* **65**, 2833-2841.
16. Purushothaman, K.K., Sarada, A., Saraswathi, G. and Connolly, J.D. 1977. 5,7-dihydroxy-6,2',4',5'-tetramethoxy-flavone from the leaves of *Chukrasia Tabularis*. *Phytochemistry* **16**, 398-399.
17. Chatterjee, A., Banerjee, B., Ganguly, S.N. and Sircar, S.M. 1974. Triterpene and coumarins from *Chukrasia tabularis*. *Phytochemistry* **13**, 2012-2013.

18. Chowdhury, R. and Islam, N. A. 2004. Hydroxylated mansumbinen-28-oic acid from *Combretum coccineum*. *Biochemical Systematics and Ecology* **32**, 443-445.
19. Sen, A.K., Banerjee, N. and Farooqi, M.I.H. 1986. Water-soluble galactomannan from the seeds of *Indigofera tinctoria* linn. *Carbohydrate Research* **157**, 251-256.
20. Kunikata, T., Tatefuji, T., Aga, H., Iwaki, K., Ikeda, M. and Kurimoto M. 2000. Indirubin inhibits inflammatory reactions in delayed-type hypersensitivity. *European Journal of Pharmacology* **410**, 93-100.
21. Islam, M.T. and Tahara, S. 2000. Dihydroflavonols from *Lannea coromandelica*. *Phytochemistry* **54**, 901-907.
22. Subramanian, S.S. and Nair, A.G.R. 1971. Polyphenols of *Lannea coromandelica*. *Phytochemistry* **10**, 1939-1940.
23. Millington, D.S. and Sheppard, R.C. 1969. Acetylenic amino acids from *Euphoria longan*. *Phytochemistry* **8**, 1227-1233.
24. Spencer, K. and Seigler, D.S. 1985. Passicoccin: a sulphated cyanogenic glycoside from *Passiflora coccinea*. *Phytochemistry* **24**, 2615-2617.
25. Hui, W., Li, M. and Wong, K. 1976. A new compound, 21 α -hydroxyfriedel-4(23)-en-3-one and other triterpenoids from *Phyllanthus reticulatus*. *Phytochemistry* **15**, 797-798.
26. Murari, M.S., Uttam, K.M. and Asok K.M. 1991. A chromenoflavanone and two caffeic esters from *Pongamia glabra*. *Phytochemistry* **30**, 3834-3836.
27. Kanungo, P.D., Ganguly, A., Guha, A., Bhattacharyya, A. and Adityachaudhury N. 1987. Glabone, a new furanoflavone from *Pongamia glabra*. *Phytochemistry* **26**, 3373-3374.
28. Gandhidasan, R., Neelakantan, S., Raman, P.V. and Devaraj, S. 1986. Components of the galls on the leaves of *Pongamia glabra*: Structures of pongagallone-a and pongagallone-b. *Phytochemistry* **26**, 281-283.
29. Pathak, V.P., Saini, T.R. and Khanna, R.N. 1983. Isopongachromene, a chromenoflavone from *Pongamia glabra* seeds. *Phytochemistry* **22**, 308-309.
30. Pathak, V.P., Saini, T.R. and Khanna, R.N. 1983. Glabrachalcone, a chromenochalcone from *Pongamia glabra* seeds. *Phytochemistry* **22**, 1303-1304.
31. Talapatra, S.K., Mallik, A.K. and Talapatra, B. 1982. Isopongaglabol and 6-methoxyisopongaglabol, two new hydroxyfuranoflavones from *Pongamia glabra*. *Phytochemistry* **21**, 761-766.
32. Talapatra, S.K., Mallik, A.K. and Talapatra, B. 1980. Pongaglabol, a new hydroxyfuranoflavone, and aurantiamide acetate, a dipeptide from the flowers of *Pongamia glabra*. *Phytochemistry* **19**, 1199-1202.
33. Khanna, R.N. and Seshadri, T.R. Pongaglabrone, a new component of the seeds of *Pongamia glabra*: its constitution and synthesis. *Tetrahedron* **19**, 219-225.
34. Pal, N., Ghosh, T.K. and Rao, C.V.N. 1984. Structural and immunochemical studies on *Pterospermum Suberifolium* gum. *Carbohydrate Research* **132**, 307-315.
35. Shinozaki, H. and Shibuya, I. 1974. A new potent excitant, quisqualic acid: Effects on crayfish neuromuscular junction. *Neuropharmacology* **13**, 665-672.
36. Gil, R.R., Lin, L., Cordell, G.A., Kumar, M.R., Ramesh, M., Reddy, B.M., Mohan, G.K. and Rao, A.V.N.A. 1995. Anacardoside from the seeds of *Semecarpus anacardium*. *Phytochemistry* **39**, 405-407.
37. Murthy, S.S.N. 1988. Semecarpetin, a biflavanone from *Semecarpus anacardium*. *Phytochemistry* **27**, 3020-3022.
38. Murthy, S.S.N. 1985. Jeediflavanone - a biflavanoid from *Semecarpus anacardium*. *Phytochemistry* **24**, 1065-1069.
39. Murthy, S.S.N. 1983. A biflavanoid from *Semecarpus anacardium*. *Phytochemistry* **22**, 1518-1520.
40. Murthy, S.S.N. 1983. A biflavanone from *Semecarpus anacardium*. *Phytochemistry* **22**, 2636-2638.
41. Rao, N.S.P., Row, L.R. and Brown, R.T. 1973. Phenolic constituents of *Semecarpus anacardium*. *Phytochemistry* **12**, 671-681.
42. Yahara, S., Nakamura, T., Someya, Y., Matsumoto, T., Yamashita, T. and Nohara, T. 1996. Steroidal glycosides, indiosides A-E, from *Solanum indicum*. *Phytochemistry* **43**, 1319-1323.
43. Yadava, R.N. and Rathore, K. 2001. A new cardenolide from the seeds of *Terminalia bellerica*. *Fitoterapia* **72**, 310-312.
44. Nandy, A.K., Podder, G., Niranjana, P., Sahu, N.P. and Mahato SB. 1989. Triterpenoids and their glucosides from *Terminalia bellerica*. *Phytochemistry* **28**, 2769-2772.
45. Wu, J., Xiao, Q., Zhang, S., Li, X., Xiao, Z., Ding, H. and Li, Q. 2005. Xylocensins Q-V, six new 8,9,30-phragmalin ortho ester antifeedants from the Chinese mangrove *Xylocarpus granatum*. *Tetrahedron* **6**, 8382-8389.
46. Wu, J., Zhang, S., Xiao, Q., Li, Q., Huang, J., Long, L. and Huang, L. 2004. Xylocensin L, a novel limonoid from *Xylocarpus granatum*. *Tetrahedron Letters* **45**, 591-593.
47. Kokpol, U., Chavasiri, W., Tip-pyang, S., Veerachato, G., Zhao, F., Simpson, J. and Weavers, R.T. 1996. A limonoid from *Xylocarpus granatum*. *Phytochemistry* **41**, 903-905.
48. Alvi, K.A., Crews, P., Aalbersberg, B. and Prasad, R. 1991. Limonoids from the fujian medicinal plant dabi (*xylocarpus*). *Tetrahedron* **4**, 8943-8948.
49. Jossang, A., Zahir, A. And Diakite, D. 1996. Mauritian J, a cyclopeptide alkaloid from *Zizyphus mauritiana*. *Phytochemistry* **42**, 565-567.
50. Srivastava, S.K. and Srivastava, S.D. 1979. Structure of zizogenin, a new sapogenin from *Zizyphus mauritiana*. *Phytochemistry* **18**, 1758-1759.